Space Weather Technical Forecast

Issued on Friday 14 February 2025 at 12:08 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of R1, G1. Increased Chance of Active 24-hour electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured by GOES16 remained at Moderate levels, with the peak flare an M1.2 at 14/0228UTC from an arriving region on the southeastern limb, with this then repeated elsewhere in the form of an M1.2 from AR3990 in the southeast at 14/1006UTC.

There are currently up to nine sunspot regions on the visible disc, of which seven are numbered. The region responsible for the peak flare will likely add to this tally of regions over the remainder of the UTC day. The main changes in the period have been continued development in AR3992 in the southwest, which saw a spreading tendency and a trend towards a more open character, however its trailing spot began to increase in size late in the period to leave a Dsi/Beta region. Also of note is AR3990 in the southeast, which saw some minor leading spot growth and the retention of a number of small pores circulating its large asymmetric penumbral spot, although for now it remains a Cki/Beta-Gamma. The main other changes were rapid growth of AR3994 in the south-centre from plage, forming a Dro/Beta. Meanwhile, a second unnumbered region unusually developed within CH14 to nearly bifurcate the coronal hole, with the active region eventually settling as a Cro/Beta.

No Earth-directed CMEs were observed in available imagery, although the increasing cadence of flares may yet reveal candidates once imagery becomes available.

Solar Wind / Geomagnetic Activity: Solar winds as measured at L1 by ACE, showed a probable ongoing connection to a fast wind, likely that emanating from CH14/- given the sustained negative phi angle (towards the Sun).

The solar wind speed trace was erratic due to the low solar wind density (low single figures ppcc), but showed an overall slight rise from 450 +/-50km/s to 500 +/-50km/s by the period's end. The IMF showed a slight rise from Background to Slightly Elevated levels, and an overall peak of 9nT. The north-south component varied between +6 and -9nT, with this mainly anti-aligned with Earth's field to accentuate geomagnetic activity.

The net result of the above solar wind measures was Unsettled to Active geomagnetic activity, peaking at a provisional Kp of '4+' in the UTC early hours of 14 February.

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Energetic Particles / Solar Radiation: High energy proton flux at GOES18 persisted at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 was periodically at High levels in a trace interrupted by geomagnetic activity, with a peak of 2430pfu at 13/1620UTC. The associated 24-hour fluence persisted below the Active threshold, recording a rising trend and a 14/0001UTC. value of 5.75e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of isolated M-class flares, with a level trend now expected (barring development) in the absence of any significant departures or arrivals.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Current fast winds from CH14/- are expected to continue to gradually increase through day 1 (14 February), perhaps reaching Strong speeds. Little change is then expected through the UTC weekend, before a gradual decline perhaps develops through day 4 (17 February). Often Unsettled to Active, there is a Chance of G1 into the coming UTC weekend, waning in likelihood by the new working week.

Energetic Particles / Solar Radiation: High energy proton flux is forecast to persist at Background levels, with a marginally increasing Slight Chance of a S1 event given the westward progression of current active regions.

The high energy electron flux is now expected to show a rising day-on-day Chance of breaching Active fluence, perhaps becoming Likely into the new UTC working week. Confidence is low, and the forecast may prove volatile until CH14 more fully settles in its character and effect at Earth.

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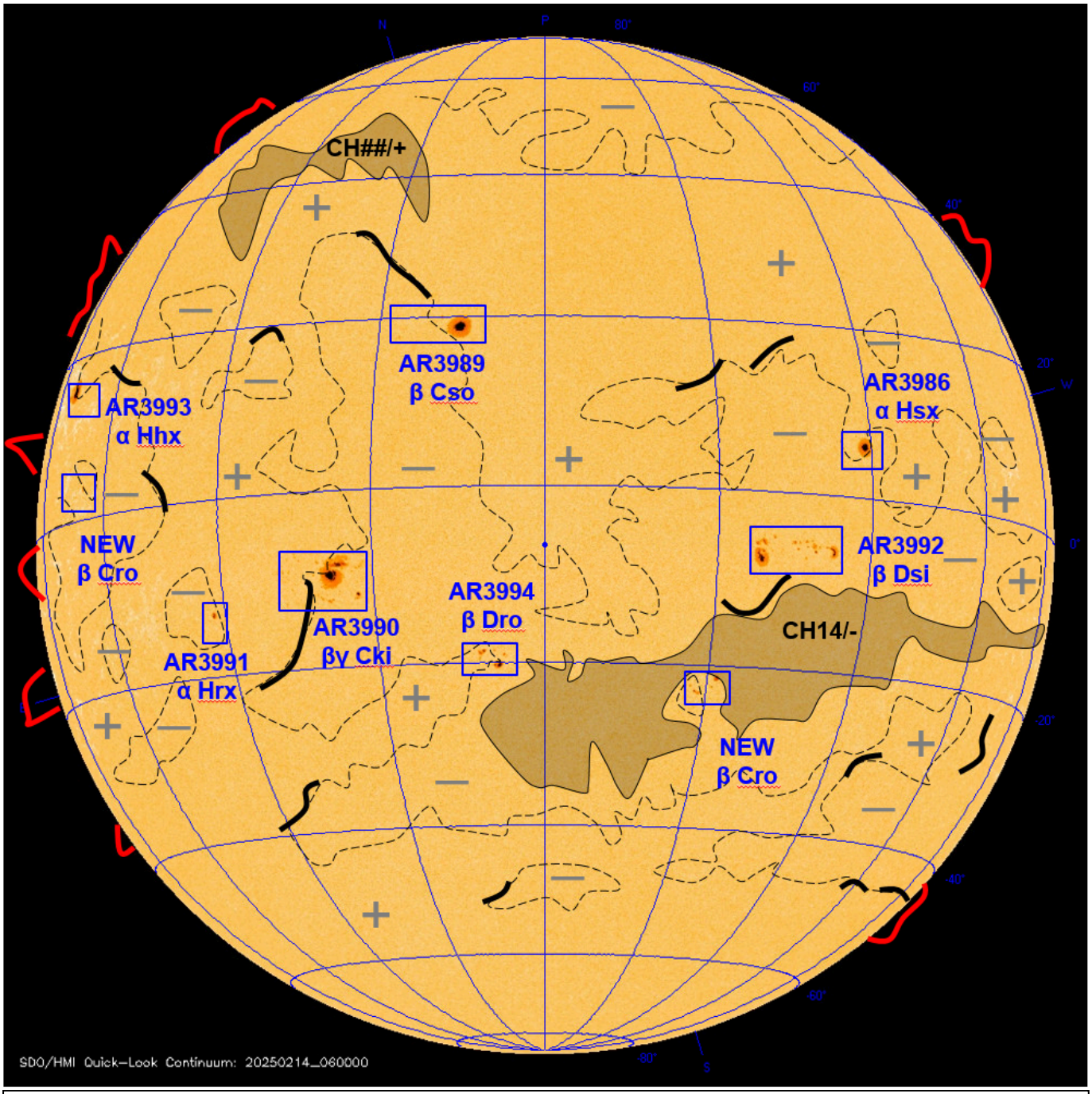
Figure 1: Latest MOSWOC solar synoptic map, valid 14/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

No CMEs feature in the forecast, which instead consists solely of the probable strengthening of the current coronal hole fast wind from CH14/-.

The unusual development of a new sunspot region near 020W within the boundaries of CH14/- has perhaps occurred too late to have any impact on the continuity of its fast wind at Earth, and the previous thoughts of a sustained period of restive geomagnetic active are maintained. The latest MOSWOC Enlil run persists in its thoughts of a week-long 600km/s fast wind, which is felt to be unphysical given the stature of the causative coronal hole. Instead, a gradual rise and then fall over a roughly four-day span is perhaps preferred, with speeds peaking around 550-600km/s, i.e. a slight increase may yet occur. It is now becoming less likely that there will be any significant marker in the transition between CH13 and CH14, with the tenuous link between these perhaps affecting Earth through the past couple of days before the recent resurgence.

Predominantly Unsettled to Active geomagnetic conditions are Expected throughout, with a Chance of G1/Minor geomagnetic storm (Kp 5) intervals that should peak into the current UTC weekend before gradually tailing off by the new UTC working week. The main forecast uncertainty is perhaps the duration of the enhancement, although the peak magnitude is not likely to depart from G1.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	40	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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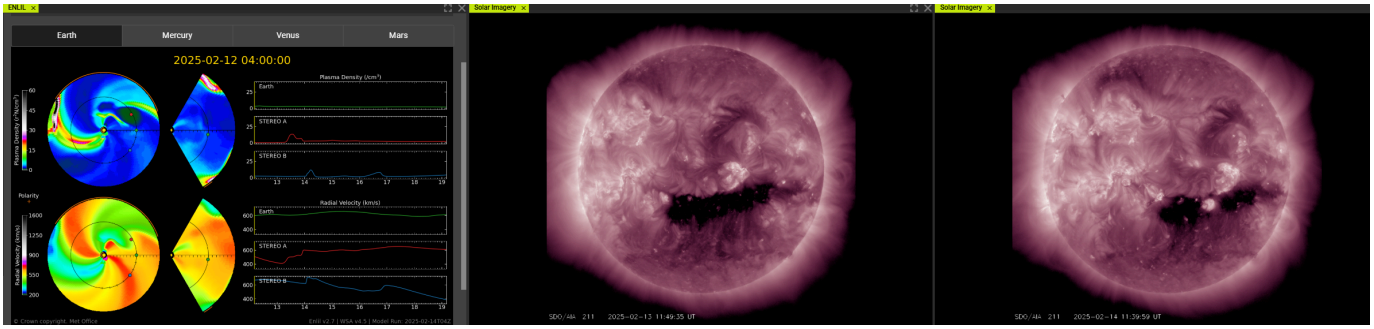
Figure 2: Left: Latest MOSWOC Enlil run, showing unphysical seven-day fast wind from CH14/-, with a duration nearer four days perhaps preferred from its current appearance (far right). Also shown are two 24-hour separated AIA211 images that highlight the emergence of a new sunspot region within the coronal hole, although this likely developed too late to have any bearing on the continuity of the coronal hole fast wind at Earth.



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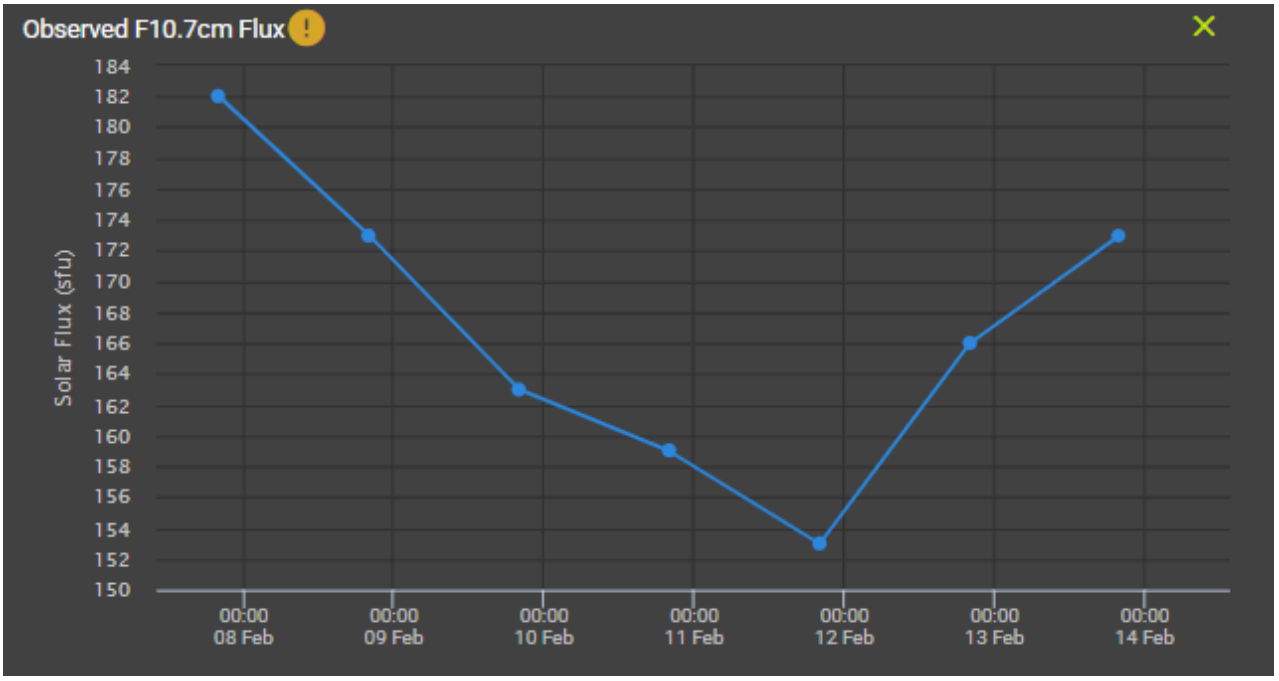
Radio Blackouts - X-Ray Flares

The Penticton 10.7cm value has seen a day-on-day rise to a current value of 173sfu during the second half of the current working week in a proxy for the proliferation of front-sided regions. This now gives a total of up to nine groups, which will likely shortly be joined by an M-class producing tenth on the southeastern solar horizon. There are no further significant arrivals signalled, and none of the current Earth-facing regions leave the disc in the period, so trends are then exclusively tied to development or decay.

There is a Chance of further isolated M-class flares, most likely from AR3992 or the arriving southeast limb region, although AR3990 perhaps warrants monitoring for increased complexity. The probabilities of flares show a flat trend in the period, with M and X-class both marginally more likely than of late.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	50	50	50	50
Very Active	R3-R5 (X Class)	No	5	5	5	5

Figure 3: Penticton 10.7cm flux through the past week, showing a midweek lull that has now nearly fully reversed.



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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is most likely to persist at Background levels, but with a slowly increasing daily Slight Chance of enhancement from any notable flares from AR3992 as it rotates further across the western hemisphere. The increase in this risk is too slight to feature in the S1 probabilities, however. The 14/1006UTC flare is felt to have occurred long enough ago and far enough east to have a negligible additional risk on solar radiation storm probabilities in the immediate term.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

Confidence in the high energy electron forecast has fallen in recent hours, with the solar wind and sustained geomagnetic activity from CH13 into CH14 of marginal magnitude to charge but not significantly compress the Van Allen belt and its High electron populations at GEO. Occasional drop-outs to Normal Background flux are still probable, but the recent GOES16 peak value above 2000pfu at 14/0300UTC hints that a higher magnitude diurnal oscillation is very possible given that this occurred near the usual daily minimum. MOSWOC REFM is proving quite reactive to current counts at GEO and has recently reversed its previous forecast of a day-on-day decline, instead preferring something rising to near Active. These thought are tentatively accepted, and it is perhaps now odds-on once again for Active fluence to greet the new UTC working week. This forecast may remain volatile until CH14/- more fully settles.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	30	50	50	60
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	5

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Figure 4: Left: Latest MOSWOC REFM, showing a greatly-slowed falling 72-hour forecast trend that may yet reverse entirely to show a rise to nearer Active fluence. Right: Past 3 UTC days of L1 solar wind speed at ACE; BGS 3-hourly geomagnetic indices; and resultant GOES16 high energy electron flux. Electron flux levels are marginal at GEO between an increasing oscillation and compression inside this radius.

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